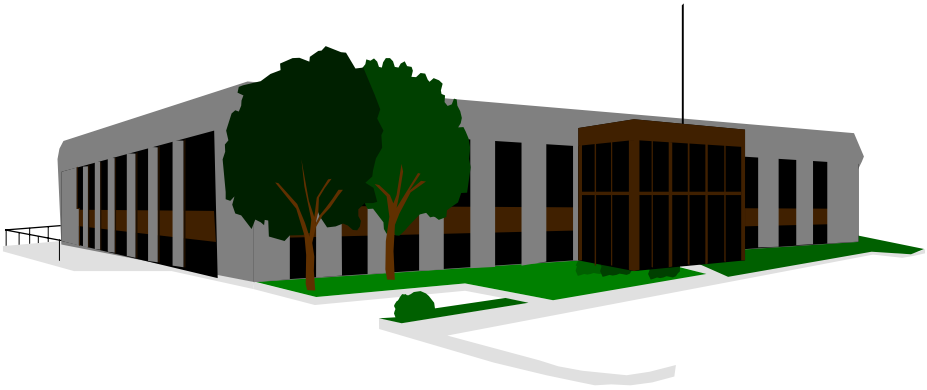
INDOOR AIR QUALITY ASSESSMENT

Dolbeare Elementary School
340 Lowell Street
Wakefield, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
May, 2000

Background/Introduction

At the request of the Wakefield Board of Health an indoor air quality assessment was done at the Dolbeare Elementary School in Wakefield, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA).

On March 23, 2000, a visit was made to this school by Cory Holmes, Environmental Analyst, Emergency Response/Indoor Air Quality Program (ER/IAQ), BEHA to conduct an indoor air quality assessment. Mr. Holmes was accompanied for portions of the assessment by Sam Stella, Wakefield Board of Health; Margaret McGrath, Principal, Dolbeare Elementary School; Patty de Garavilla, Assistant to the Principal; and Captain Michael Sullivan of the Wakefield Fire Department. This request was prompted by indoor air quality issues concerning sewer gas odors reported in the school. Methods for preventing sewer gas odors from penetrating into the building were addressed by BEHA staff and a letter was issued (MDPH, 2000), see Appendix A.

The original building is a single-story red brick building constructed in 1953. Four rooms were added to the west side of the building in 1957. A two-story addition was completed in 1999 on the eastern side of the school. The second floor contains general classrooms, media center, several small offices and a computer room. The first floor consists of general classrooms, music room, gymnasium, cafeteria and office space. Windows are openable throughout the school.

Methods

Air tests for carbon dioxide were taken with the Telaire, Carbon Dioxide Monitor and tests for temperature and relative humidity were taken with the Mannix, TH Pen

PTH8708 Thermo-Hygrometer. Tests for hydrogen sulfide (H_2S) and carbon monoxide (CO) were taken using a BW Defender, Multi-gas Detector. CO measurements were taken throughout the building as well as outside for comparison to indoor levels. H_2S measurements were taken outside for comparison to indoor levels (i.e., main office reception area and in areas thought to be impacted by potential sewer gas odors).

Results

This school houses pre-kindergarten through 4th grade students and contains a student population of approximately 500 and a staff of approximately 75. The tests were taken during normal operations at the school. Test results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in two of twenty-four areas surveyed, which would indicate adequate fresh air ventilation in most areas of the school. It should be noted however, that a number of areas throughout the school had open windows or were sparsely populated during the assessment, which can greatly contribute to reduced carbon dioxide levels. Fresh air in classrooms is supplied by a mechanical unit ventilator (univent) system. A univent draws fresh air from a vent on the exterior of the building and air from the classroom (called return air) through a vent in the base of its case (see Figure 1). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the case. The majority of univents were operating during the assessment, however BEHA staff noted several that had been deactivated (see Tables). Without mechanical ventilation, fresh air cannot be introduced into classrooms on a

consistent basis. Obstructions to airflow, such as items stored on univent air diffusers as well as computer carts and furniture in front of univent return vents were also noted in classrooms (see Picture 1). In order for univents to provide fresh air as designed, univent air diffusers and return vents must remain free of obstructions. Importantly, these units must remain activated while classrooms are occupied. Rooftop air-handling units (AHUs) provide ventilation for the common areas (e.g., office areas, gymnasium, cafeteria, etc.). These units were operating during the assessment.

Wall-mounted intake grills connected to ductwork provide mechanical exhaust ventilation in the original building and the 1957 addition. Airflow into the original building exhaust vents is controlled by a flue/damper located inside the duct attached to a pull chain (see Picture 2). The vent in classroom 106 was drawing weakly, indicating that the damper may be closed. A number of exhaust vents were also obstructed by file cabinets, bookcases and other items (see Picture 3). As with the univents, in order for exhaust ventilation to function as designed, exhaust vents must remain free of obstructions. For areas serviced by rooftop AHU equipment exhaust ventilation is provided by ceiling-mounted return vents connected to ductwork. These vents were functioning during the assessment.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a univent and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air. The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (BOCA, 1993, SBBRS, 1997). The ventilation must be on at all times that the room is

occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this occurs a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings were within a range of 70^0F to 77^0F, which was within BEHA's recommended comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70^0F to 78^0F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Complaints of cold temperatures were expressed to BEHA staff in classroom 205. Univents are equipped with controls, which can be set on three different settings: low, medium or high. When the temperature requirement is met (as determined by

the thermostat setting) the heat to the univent cycles off and cool outside air is provided by the unit. BEHA staff also noted that the occupant's desk was within the return vent air stream of the univent. As the univent operates it can create air currents that are pulled across occupants seated near the equipment. BEHA staff recommended that the occupant relocate her desk. In order to provide maximum intake of outside air, univents should be operated in the "high" setting.

The relative humidity in this building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 10 to 20 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several areas had water-stained ceiling tiles (see Picture 4), which are evidence of historic roof or plumbing leaks. Water-damaged ceiling tiles can provide a source of mold and mildew and should be replaced after a water leak is discovered, and repaired.

Several classrooms had a number of plants. Moistened plant soil and drip pans can serve as a source of mold growth. Classroom 202 had flowering plants on top of univents (see Picture 5). Plants should be equipped with drip pans and located away from univents to prevent the aerosolization of dirt, pollen or mold.

Other Concerns

Several other conditions were noted during the assessment, which can affect indoor air quality. The teacher's workroom contained two lamination machines and two photocopiers. Also noted were a mimeograph machine and a container of mimeograph duplicating fluid (see Picture 6). Lamination machines can produce heat and irritating odors during use. Mimeograph duplicating fluid contains methanol (methyl alcohol), which is a volatile organic compound that readily evaporates at room temperature. The off gassing of this material can also be irritating to the eyes, nose and throat. Methanol is also a highly flammable material, which can be ignited by either flame or electrical source. Excess heat, volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). Occupants should ensure exhaust ventilation is activated while equipment is in use to help reduce excess heat and odors in this room.

A number of classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999). Cleaning products were stored under sinks as well as on tables and countertops in a number of classrooms (see Picture 7). These materials should be stored properly and kept out of reach of students. In addition, a number of classrooms contained unlabeled spray bottles. Products should be kept in their original containers, or should be clearly labeled as to their contents, for identification purposes in the event of an emergency. Cleaning products, dry erase board markers and cleaners can be irritating to the eyes, nose and throat.

Conclusions/Recommendations

In view of the findings at the time of our inspection, the following recommendations are made:

1. Implement the corrective actions recommended by BEHA in the previous letter concerning sewer gas odors (see Appendix A).
2. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Check fresh air intakes for repair and increase the percentage of fresh air intake if necessary. Operate univents while classrooms are occupied, repair if needed.
3. Have exhaust ventilation operate during occupancy. Inspect exhaust motors and belts for proper function, repair and replace as necessary.
4. Remove all blockages from univents and exhaust vents. Examine flue systems for proper function, repair if necessary.
5. Consider having the ventilation system balanced by a professional heating, ventilating, and air conditioning (HVAC) engineer.
6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
7. Modify classroom 205 configuration to remove occupant from the return vent air stream of univent.

8. Repair any existing water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.

9. Move plants away from univents in classrooms. Ensure drip pans are placed underneath plants in classrooms. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.

10. Acquire current Material Safety Data Sheets for all products that are used in the building that contain hazardous materials, including office supplies, in conformance with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).

11. Ensure exhaust ventilation is activated in teacher's room to help reduce lamination machine and photocopier odors. Consider reducing or discontinuing use of mimeograph machines.

12. Store chemicals and cleaning products properly and out of the reach of students. Be sure all materials are labeled clearly.

References

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

MDPH. 2000. Letter Addressing Sewer Gas Odors Reported at the Dolbeare Elementary School, Wakefield, MA. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA. April 2000.

MGL. 1983. Hazardous Substances Disclosure by Employers. Massachusetts General Laws. M.G.L. c. 111F.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

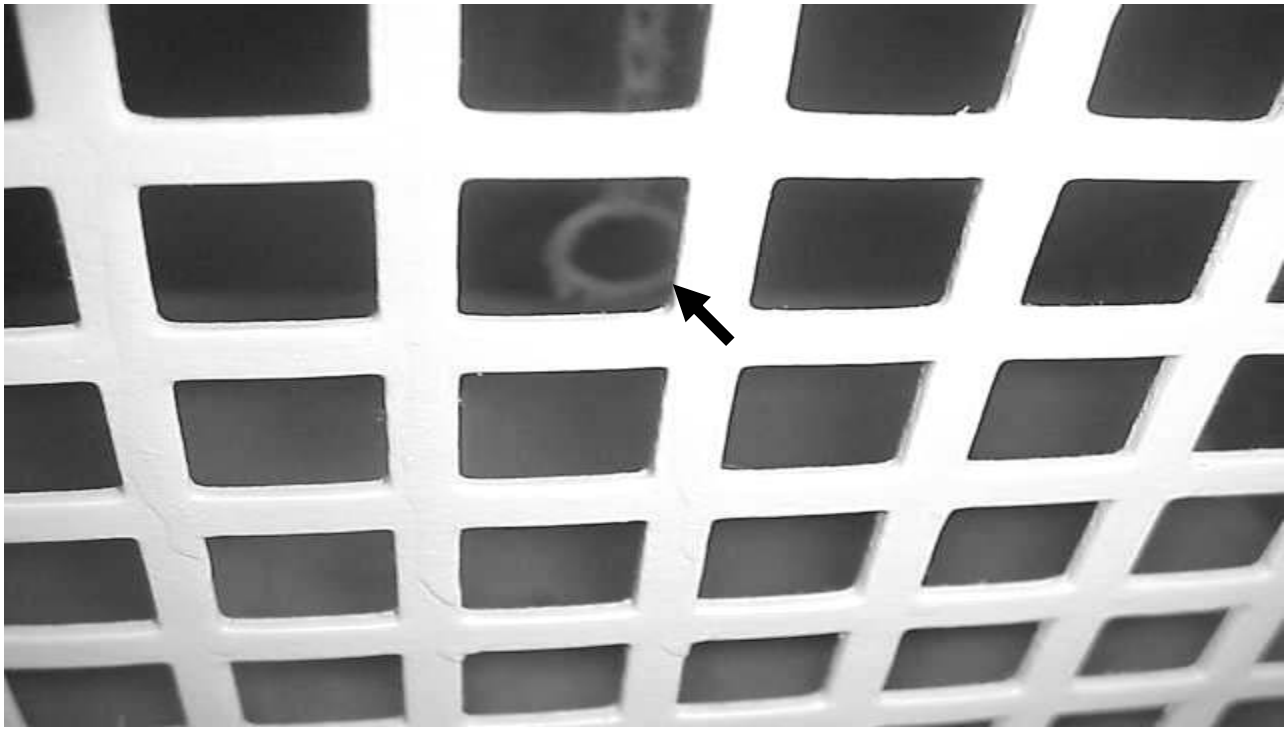
SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

Picture 1

Classroom Univent: Note Return Vent (front-lower portion of unit) is Blocked With Items Obstructing Airflow

Picture 2



Exhaust Grill Noted in Classroom 106
Note Pull Chain (hanging) Connected to Flue/Damper inside Vent

Picture 3

Classroom Exhaust Vent Obstructed by Bookshelf

Picture 4

Water Stained Ceiling Tiles

Picture 5

Flowering Plants Noted Over Univent Air Diffuser in Classroom

Picture 6

Mimeograph Machine and Duplicating Fluid Noted in Teacher's Workroom

Picture 7

Cleaning Products Noted under Sink in Classroom

TABLE 1

Indoor Air Test Results – Dolbeare Elementary School, Wakefield, MA – March 23, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	348	65	18					weather conditions: clear, sunny, light breeze - Hydrogen Sulfide H_2S=0; Carbon Monoxide (CO)=0
Conference Room	656	72	17	4	no	yes	yes	H_2S=0; CO=0
Secretary's Area (Main Office)	588	74	14	4	no	yes	no	H_2S=0; CO=0
Restroom							yes	no passive door vent
St-2: Mechanical Room								HVAC equipment
Roof								sewer vent pipes 7' from air intake (capped), wind SE-toward air intake
Room 205	857	74	15	16	yes	yes	yes	2 CT, univent-cold complaints
Room 204	600	76	13	0	yes	yes	yes	univent return blocked, unlabeled cleaning product on counter
Women's Restroom							yes	
Room 202	621	73	14	0	yes	yes	yes	flowering plants over univent, cleaning product under sink, H_2S=0; CO=0

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Dolbeare Elementary School, Wakefield, MA – March 23, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 129	684	75	18	22	yes	yes	yes	univent return blocked by storage carts, H_2S=0; CO=0
Room 130	684	73	16	21	yes	yes	yes	H_2S=0; CO=0
Room 131	694	73	16	21	yes	yes	yes	window open, cleaning product on sink, H_2S=0; CO=0
Room 132	690	73	17	20	yes	yes	yes	cleaning product on sink, H_2S=0; CO=0
Room 133-B	580	78	13	0	yes	yes	yes	sewer gas odors, door open, H_2S=0; CO=0
Gym	477	77	10	22	yes	yes	yes	H_2S=0; CO=0
Room 127	474	70	19	0	yes	yes	yes	window open
Room 126	477	73	15	0	yes	yes	yes	H_2S=0; CO=0
Art Room	465	77	15	0	yes	yes	yes	indoor air quality (IAQ) complaints, ammonia containing cleaning product hanging on dry erase board, room used 2-3 days/week, very clean, H_2S=0; CO=0

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Dolbeare Elementary School, Wakefield, MA – March 23, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 121	565	75	17	21	yes	yes	yes	window and door open, H_2S=0; CO=0
Room 120	746	73	20	13	yes	yes	yes	cleaning product on sink, H_2S=0; CO=0
Room 119	781	74	17	21	yes	yes	yes	exhaust blocked by cart-vent in cabinet, door open, H_2S=0; CO=0
Room 118	886	74	19	22	yes	yes	yes	exhaust vent-in cabinet-blocked, window open
Room 116	798	77	15	25	yes	yes	yes	exhaust vent blocked by poster, window and door open, H_2S=0; CO=0
Room 123	640	76	14	3	yes	yes	yes	H_2S=0; CO=0
Room 125	621	74	17	5	no	yes	no	H_2S=0; CO=0
Room 106	495	75	17	4	yes	yes	yes	exhaust weak-damper may be closed-pull chain, window open
Room 107	608	75	19	4	yes	yes	yes	univent off, exhaust blocked by file cabinet, H_2S=0; CO=0
Room 112	710	75	17	1	yes	yes	yes	door open

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CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Dolbeare Elementary School, Wakefield, MA – March 23, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
	730	76	16	3	yes	yes	yes	door open, H_2S=0; CO=0
Teacher's Room	595	76	12	2	yes	yes	yes	2 lamination machines, 2 photocopiers, mimeograph/duplicating fluid, return vent, H_2S=0; CO=0

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%